



# Sea Ice Results from CESM Simulations

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# CESM Atmospheric Components

Community Atmosphere Model version (CAM5.1):

- New RRTM radiation, MG microphysics, Aerosols, UW PBL, TMS
- New tuning and bug fixes
- 300-year control and three 20<sup>th</sup> century ensemble members
- RCPs are underway

Whole Atmosphere Community Climate Model (WACCM<sub>4</sub>):

- High top at approximately 150km (CAM is at 40km).
- CAM<sub>4</sub> physics + TMS
- 200-year control and three 20<sup>th</sup> century ensemble members
- Three RCPs (2.6, 4.5, 8.0) complete

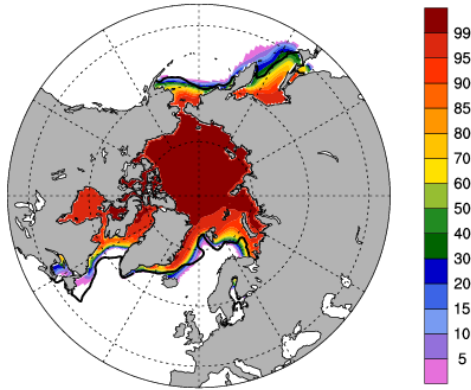
# Turbulent Mountain Stress (TMS)

- Gravity wave drag redistributes momentum, due to unresolved gravity waves, from the mid-troposphere.
- TMS is an additional form drag that redistributes momentum from the surface sub-grid scale topography.
- Both physically realistic and complementary.

# Arctic Sea Ice Concentration (JFM)

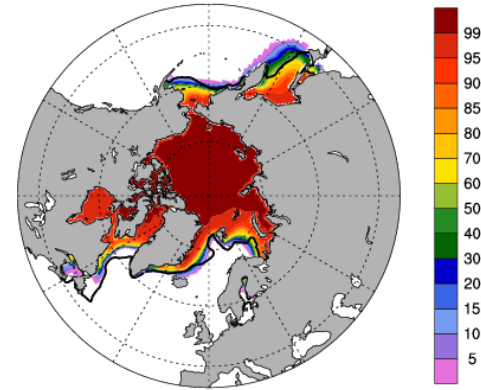
## CESM-CAM5.1 E1

JFM Mean Years 1981-2000  
ice area (aggregate) %



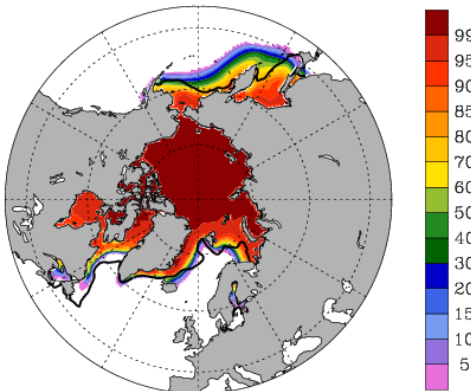
## CESM-CAM5.1 E2

JFM Mean Years 1985-2004  
ice area (aggregate) %



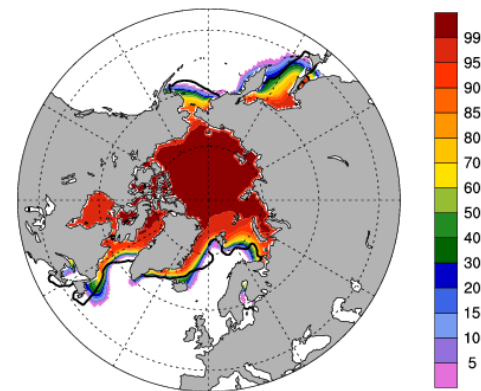
## CESM-WACCM4 E1

JFM Mean Years 1986-2005  
ice area (aggregate) %



## CCSM4 E1

JFM Mean Years 1981-2005  
ice area (aggregate) %

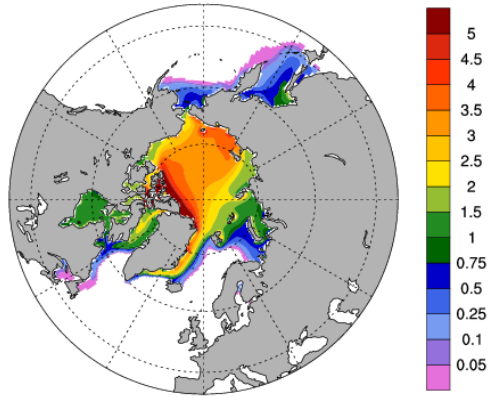


# Arctic Sea Ice Thickness (JFM)

## CESM-CAM5.1 E1

JFM Mean Years 1981-2000

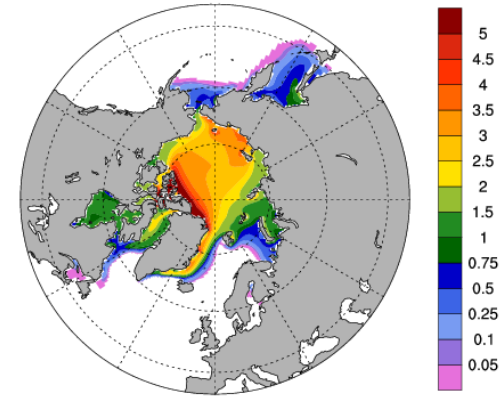
grid cell mean ice thickness m



## CESM-CAM5.1 E2

JFM Mean Years 1985-2004

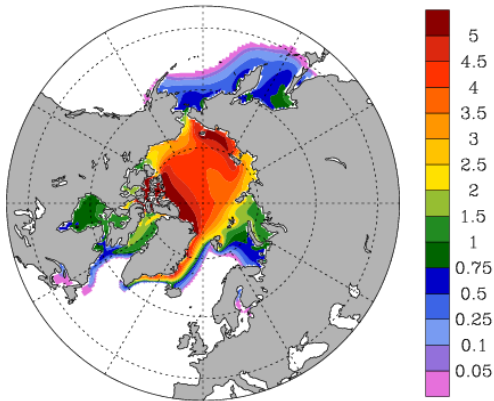
grid cell mean ice thickness m



## CESM-WACCM4 E1

JFM Mean Years 1986-2005

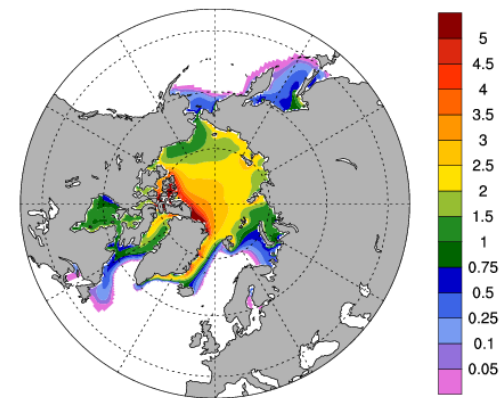
grid cell mean ice thickness m



## CCSM4 E1

JFM Mean Years 1981-2005

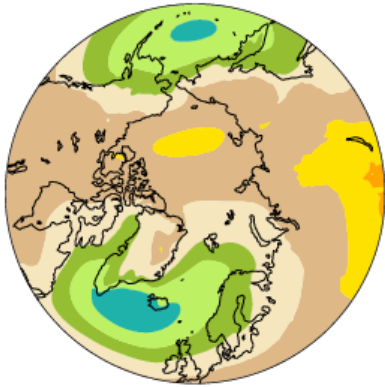
grid cell mean ice thickness m



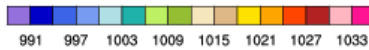
# Arctic Sea Level Pressure (ANN)

## CESM-CAM5.1 E2

Sea-level pressure millibars

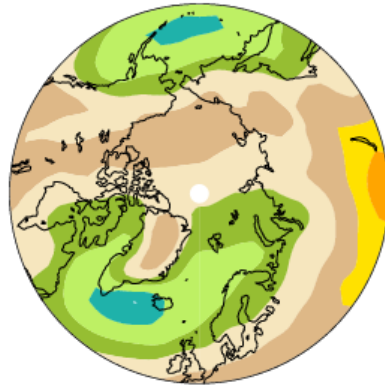


MEAN= 1013.92 Min= 1003.16 Max= 1022.62

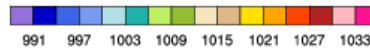


NCEP

Sea-level pressure millibars

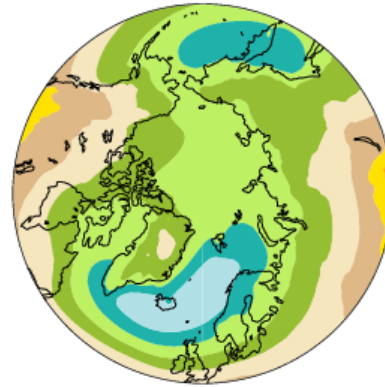


MEAN= 1012.58 Min= 1002.91 Max= 1023.11

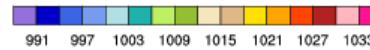


## CCSM4 E1

Sea-level pressure millibars

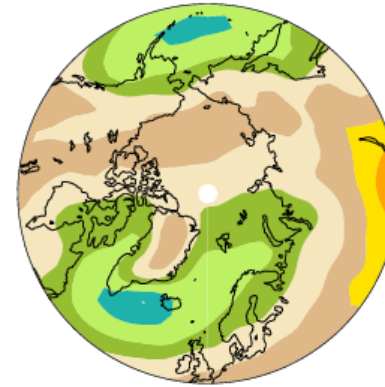


MEAN= 1009.80 Min= 1000.97 Max= 1022.23

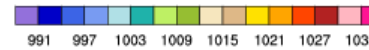


NCEP

Sea-level pressure millibars

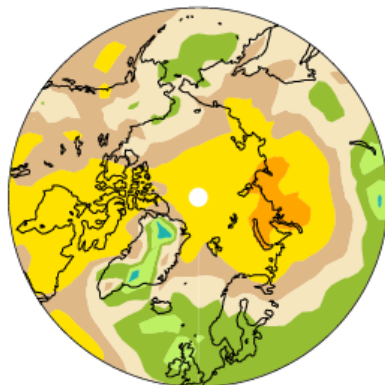


MEAN= 1012.58 Min= 1002.91 Max= 1023.11

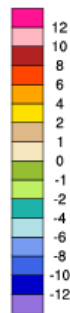


## b40\_20th\_1d\_b08c5cn\_139jp - NCEP

Sea-level pressure millibars

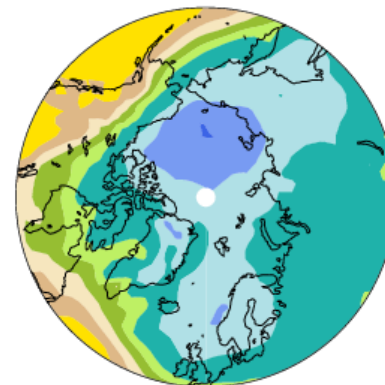


MIN = -2.78 MAX = 4.69



## b40.20th.track1.1deg.005 - NCEP

Sea-level pressure millibars



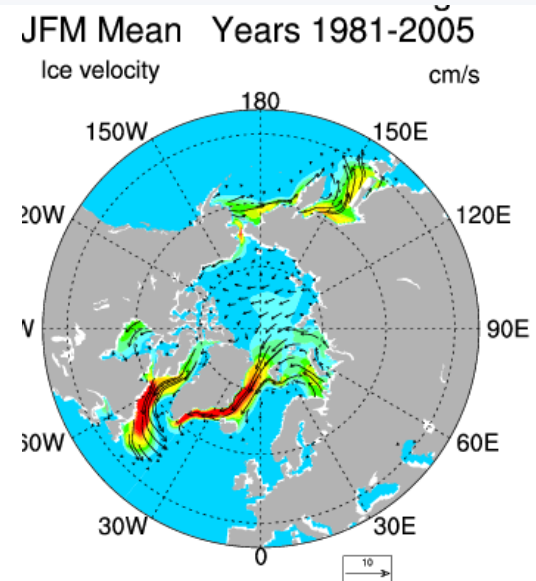
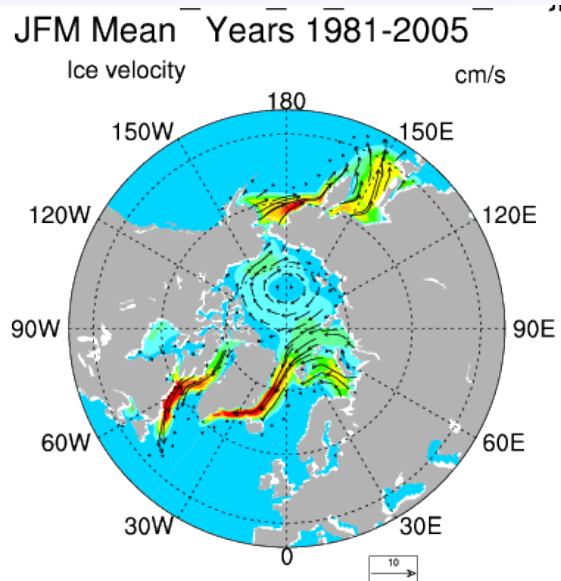
MIN = -8.02 MAX = 3.68



# Arctic Sea Ice Velocities (JFM)

CESM-CAM5.1 E2

CCSM4 E1

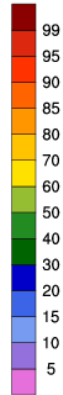
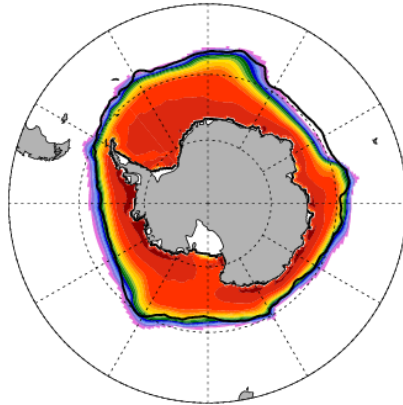


# Antarctic Sea Ice Concentration (JAS)

## CESM-CAM5.1 E1

ice area (aggregate)

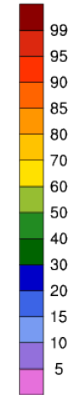
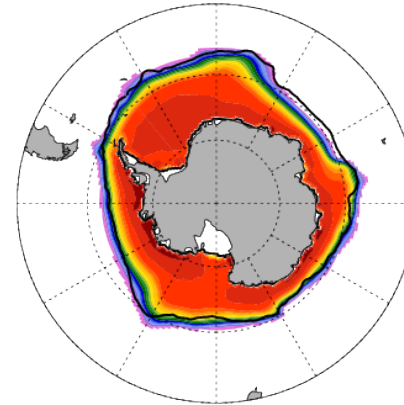
%



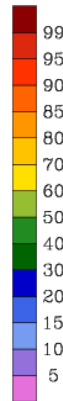
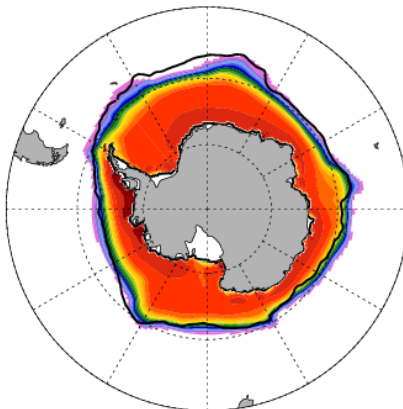
## CESM-CAM5.1 E2

ice area (aggregate)

%

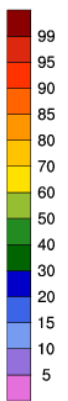
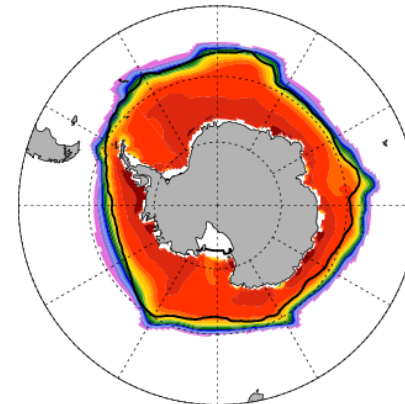


## CESM-WACCM4 E1



## CCSM4 E1

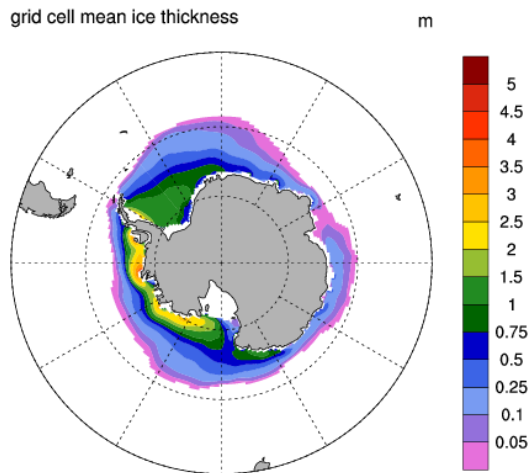
ic



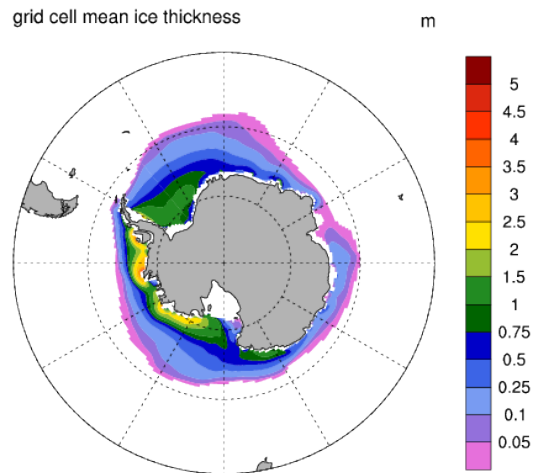


# Antarctic Sea Ice Thickness (JFM)

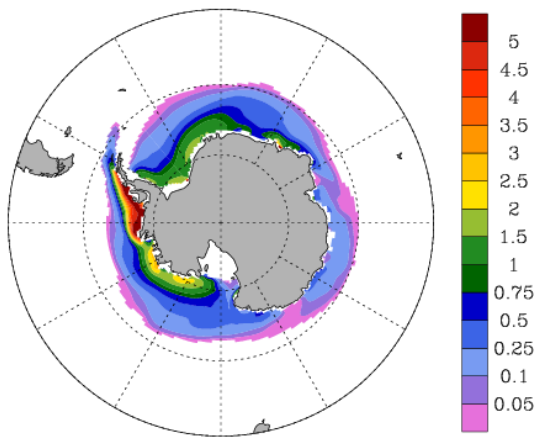
## CESM-CAM5.1 E1



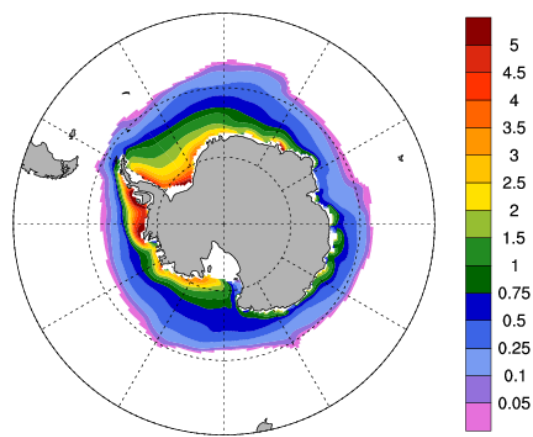
## CESM-CAM5.1 E2



## CESM-WACCM4 E1



## CCSM4 E1

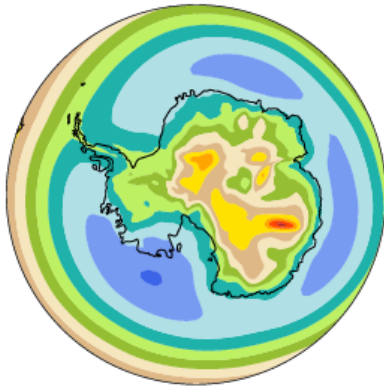


# Antarctic Sea Level Pressure (ANN)

CESM-CAM5.1 E2

NCEP

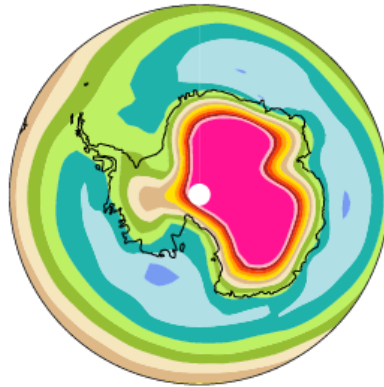
Sea-level pressure millibars



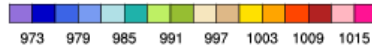
MEAN= 988.44 Min= 978.84 Max= 1009.95



Sea-level pressure millibars



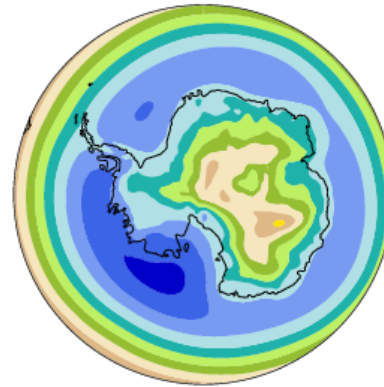
MEAN= 993.54 Min= 980.97 Max= 1036.88



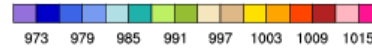
CCSM4 E1

NCEP

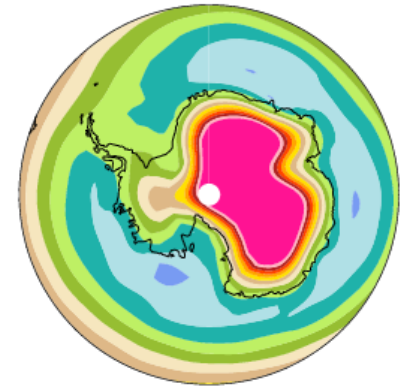
Sea-level pressure millibars



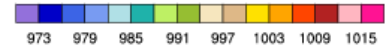
MEAN= 985.87 Min= 975.13 Max= 1000.88



Sea-level pressure millibars

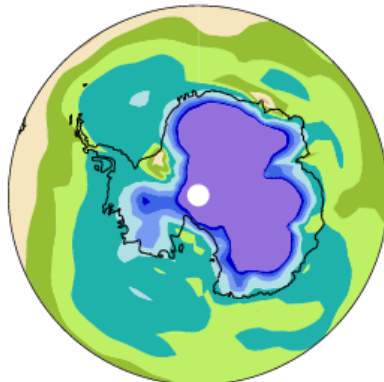


MEAN= 993.54 Min= 980.97 Max= 1036.88

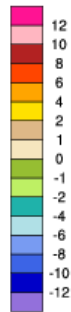


b40\_20th\_1d\_b08c5cn\_139jp - NCEP

Sea-level pressure millibars

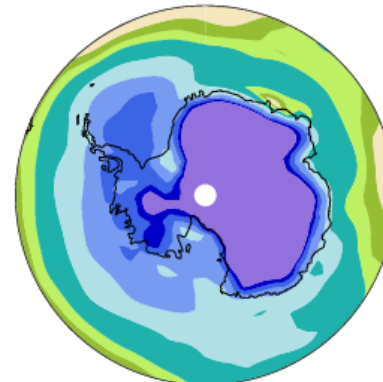


MIN = -42.38 MAX = 1.46

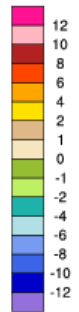


b40.20th.track1.1deg.005 - NCEP

Sea-level pressure millibars

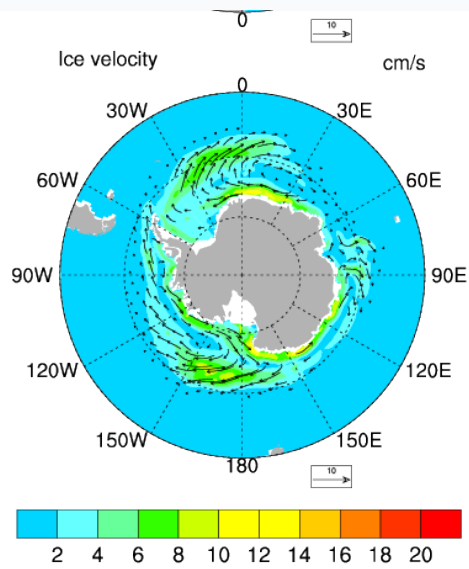


MIN = -43.16 MAX = 0.67

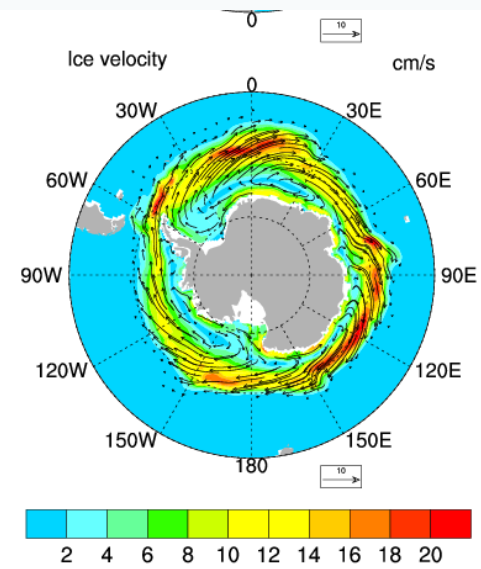


# Antarctic Sea Ice Velocities (JFM)

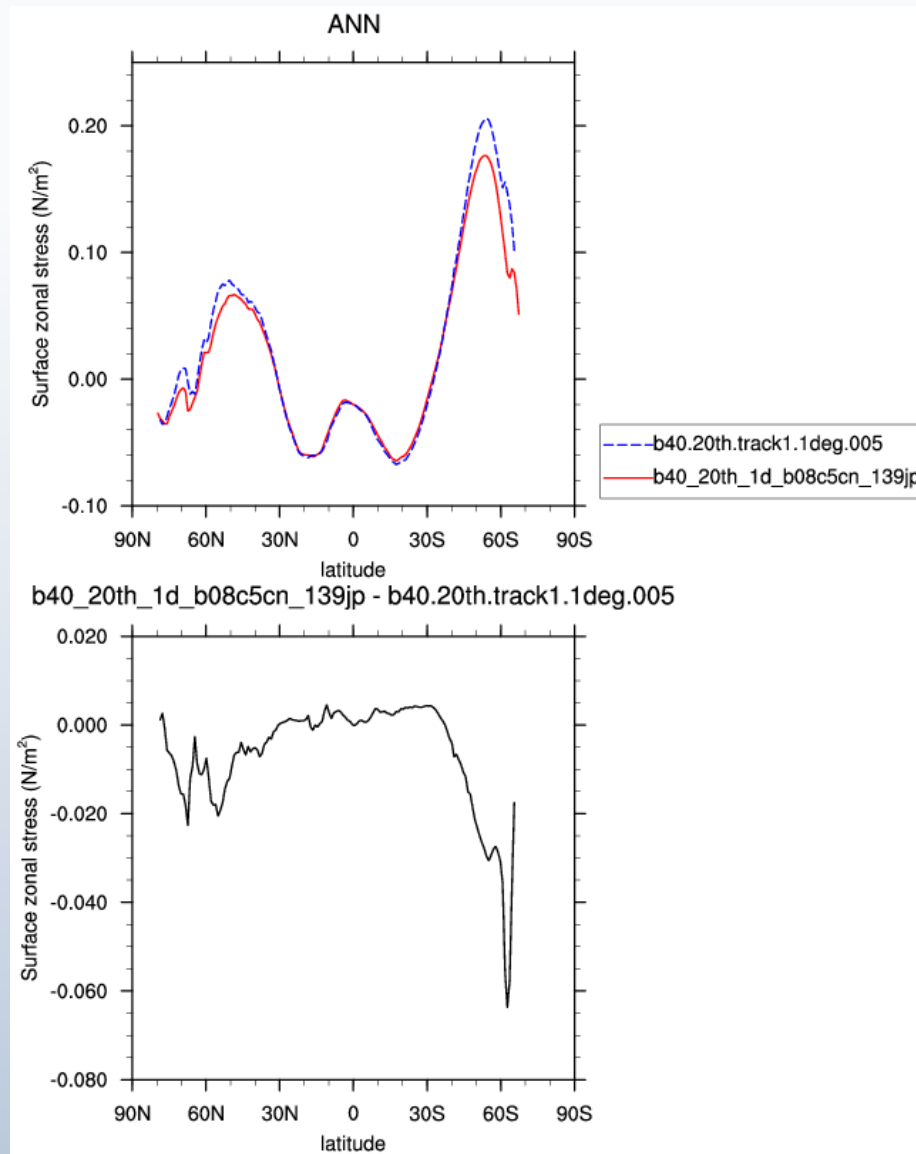
## CESM-CAM5.1 E2



## CCSM4 E1



# Zonally Averaged Wind Stress (ANN)



# Summary

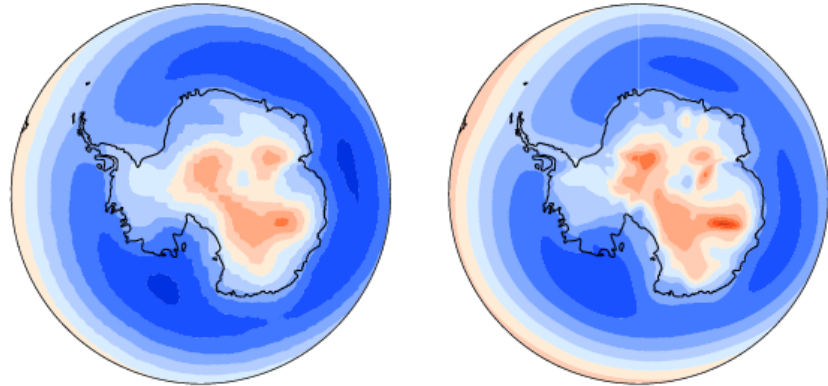
- Better atmospheric circulation and sea ice extent, but worse sea ice thickness pattern overall in CESM-CAM5.1 and WACCM4 runs.
- TMS moves surface momentum from tropics and mid-latitudes to poles -> Higher surface pressure and colder surface temperature near the pole.
- NH: Stronger surface circulation over the Arctic sea ice resulting in secondary thickness maximum north of Siberia.
- SH: Stronger circulation over the Antarctic continent, but weaker circulation over the sea ice resulting in anemic Weddell Sea circulation.
- Key points: Magnitude and location of wind stress maximum.
- Work in progress to better understand tuning of TMS parameterization, sensitivity to sub-gridscale topography, and interaction with resolution.

# Modified Topography

## ANN

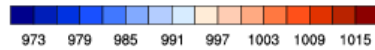
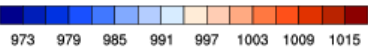
b.e10.B1850C5CN.ne30\_g16.001 (yrs 62-81) b40\_1850\_1d\_b08c5cn\_138j (yrs 300-319)

Sea-level pressure millibars      Sea-level pressure millibars



MEAN= 987.27 Min= 978.57 Max= 1003.69

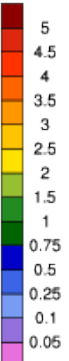
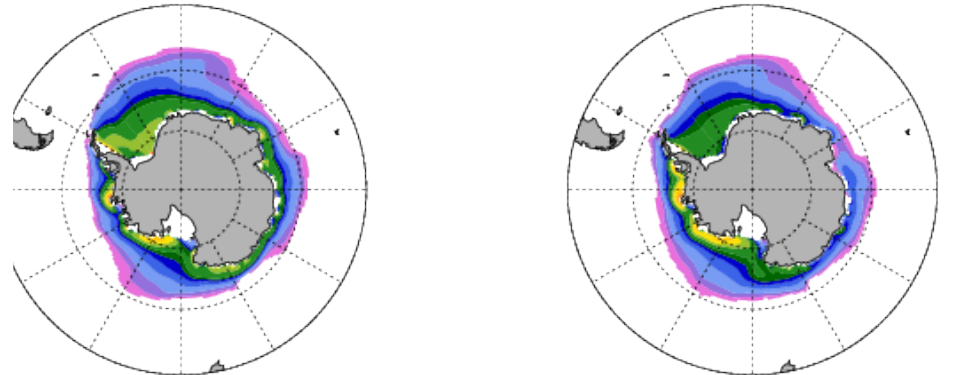
MEAN= 988.70 Min= 979.58 Max= 1010.38



## JFM Mean

50C5CN.ne30\_g16.001 Yrs 0062 - 0081 b40\_1850\_1d\_b08c5cn\_138j Yrs 0300 - 0319

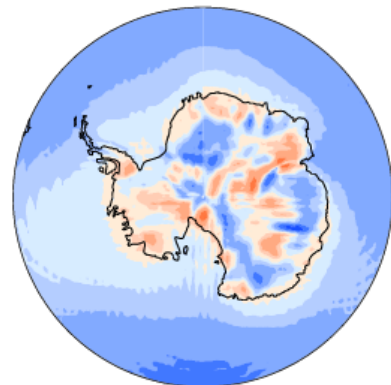
id cell mean ice thickness m      grid cell mean ice thickness m



b.e10.B1850C5CN.ne30\_g16.001 - b40\_1850\_1d\_b08c5cn\_138j

b.e10.B1850C5CN.ne30\_g16.001 - b40\_1850\_1d\_b08c5cn\_138j

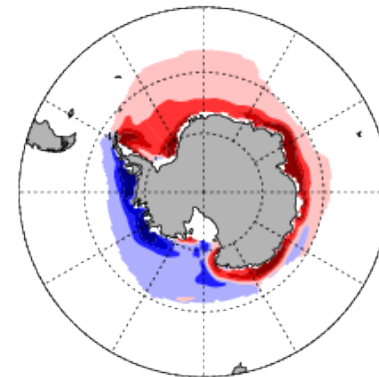
Sea-level pressure millibars



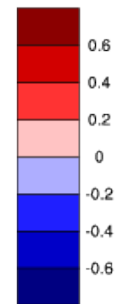
MIN = -7.56 MAX = 6.09



grid cell mean ice thickness m

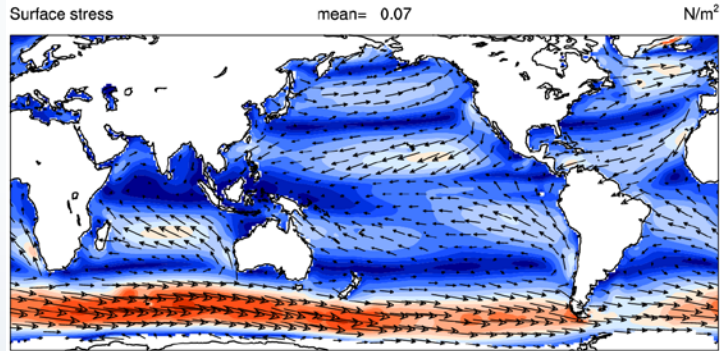


MIN = -1.70 MAX = 5.32

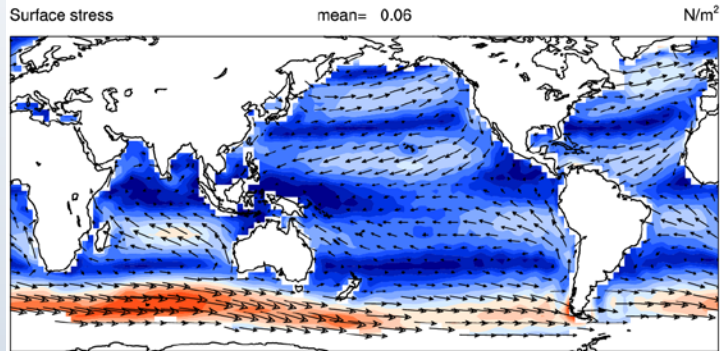


# Higher Atmospheric Resolution

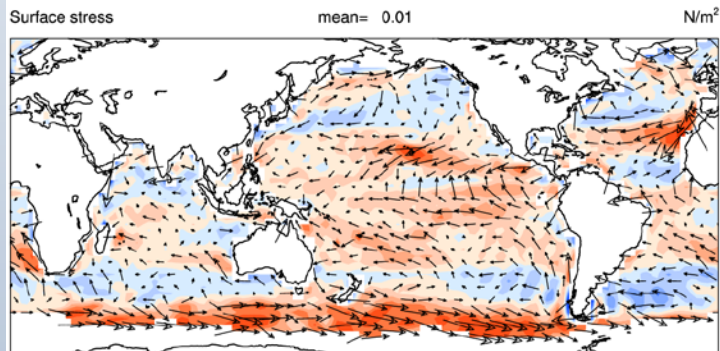
cam5.1\_amp\_1d\_002 (yrs 1981-2000)



NCEP

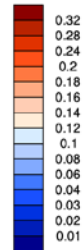


cam5.1\_amp\_1d\_002 - NCEP

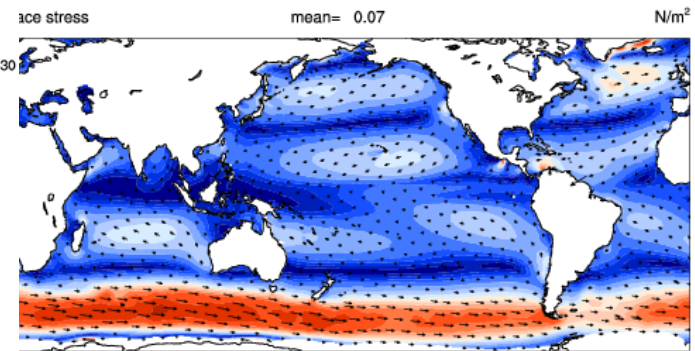


ANN

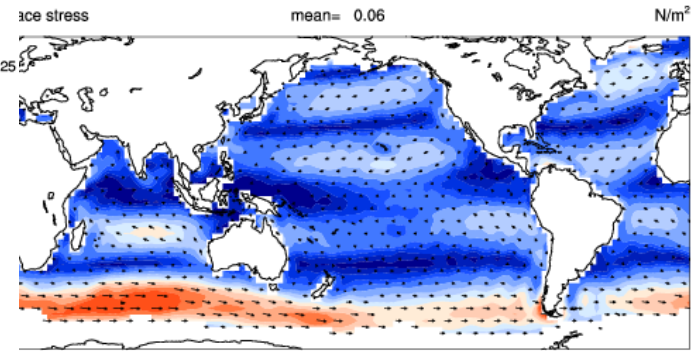
MIN = 0.00 MAX = 0.30



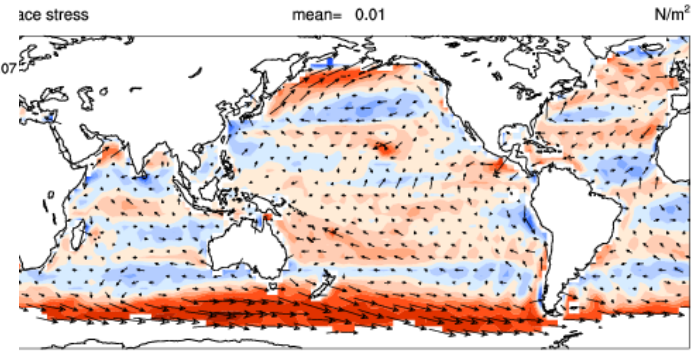
f40\_amp\_025d\_b06c4\_207jp (yrs 1985-2004)



NCEP

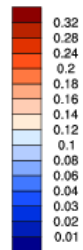


f40\_amp\_025d\_b06c4\_207jp - NCEP

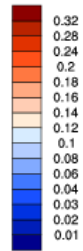


ANN

MIN = 0.00 MAX = 1.17



MIN = 0.00 MAX = 0.25



MIN = -0.09 MAX = 0.14

